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SOME OBSERVATIONS ON *MACROPORELLA RETICA* ZANIN BURI 1965 DASYCLADACEAN GREEN ALGA FROM THE UPPER TRIASSIC

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Key-words: Dasycladales, Taxonomy, Triassic (Rhaetian), Northern Italy.

Riassunto. Sono descritti i caratteri morfologici e biometrici di *Macroporella retica* Zanin Buri 1965 della località-tipo (Aviatico - Lombardia). Sulla base di queste osservazioni, come già verificato da Barattolo et al. (1993), si conferma che *Macroporella retica* è da ritenersi sinonimo più recente di *Griphoporella curvata.*

Abstract. The biometric and morphological characters of *Macroporella retica* Zanin Buri 1965 from the type-locality (Aviatico - Lombardy) are described. On the basis of these observations, it has been possible to confirm that *Macroporella retica* represents a junior synonym of *Griphoporella curvata*, as stated by Barattolo et al. (1993).

Introduction.

Griphoporella curvata (Gümbel 1872) is widespread in the Upper Triassic (Norian-Rhaetian) carbonate sequences of the tethyan domain and it is an important stratigraphic and paleoenvironmental marker.

In 1965, Zanin Buri established *Macroporella retica.* She described it as follows: rod-shaped or claviform thallus, cylindrical axial hollow, simple, tubular or phloiophorous branches, not arranged in verticils, open and perpendicular to the axis of the thallus. According to these characteristics, she attributed this alga to the genus *Macroporella*, even if she noted some small differences from the original description of the genus as emended by Pia (1912).

The type material studied by Zanin Buri, consisted of eleven thin sections containing rare, not very well or badly preserved specimens, that are stored at the Laboratory of Micropaleontology, Department of Earth Sciences of University of Milan. Therefore a rich material has been collected by the author from the type-locality, in order to performe a detailed statistical and taxonomical analysis.

The main biometric parameters have been analyzed and described. The study was also focused on a statistical comparison between the present data and those re-

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ported on *Griphoporella curvata* by Barattolo et al. (1993). As already suggested by Ott (1967) and Bassoullet et al. (1978), these authors pointed out, based only on two samples of Zanin Buri (1965), that the morphological characters of *Macroporella retica* and of *Griphoporella curvata* are very similar; small differences have been observed in the values of the biometrical parameters, in some cases slightly greater in *Macroporella retica.* In this study, I will try to prove the conclusions reached by Barattolo et al. (1993), on the base of a much larger number of specimens (about 100) of *Macroporella retica.*

Macroporella retica Zanin Buri 1965

1965 *Macroporella retica* n. sp. Zanin Buri, pl. 44, 45; pl. 61, fig. 5, 6.

Holotype. Zanin Buri (1965) illustrated about ten specimens of *Macroporella retica* in various kinds of section. She indicated as holotype the alga on plate 44 (specimen α), thin section MB - S 51.

Material and type-locality. Zanin Buri (1965) described as type-locality the outcrop generically west of Aviatico town. The only sample studied in the present paper (AV.1-28) was collected about 500 m north-west of Aviatico (I.G.M. Map 33 II NW "Albino", scale 1:25,000). The outcrop is 70 m behind the S. Rocco church, at 1050 m a.s.l. (Fig. 1). The calcareous bed, where the sample comes from, is known as "Calcari grigio-azzurri a coralli". In this area the rock exposure is often very poor because of a diffuse vegetation. On the outcrop, *Macroporella retica* is always present, although in rare fragments; only in a thin interval (about two metres), the alga is very abundant.

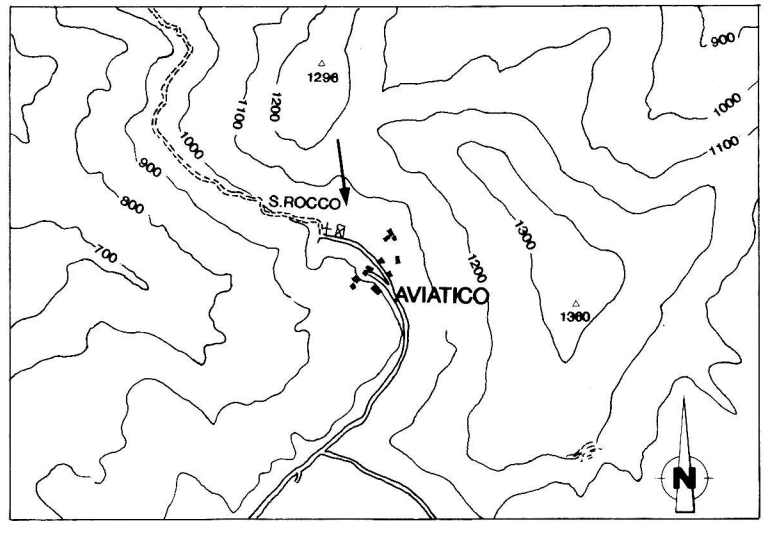

Fig. 1 - Topographic sketch of Aviatico town (drawing from I.G.M. Map 33 II NW "Albino" at scale 1:25,000). The arrow marks the type-locality of *Macroporella retica* Zanin Buri (1965).

Type-level. The thin stratigraphical sequence at Aviatico belongs to the "Calcari di Zu" formation. This unit, widely described by several authors, is constituted by a cyclic deposition of tidal limestone, marl and shale (Masetti et al., 1989), deposited during the Late Triassic (Norian-Rhaetian) syn-rift phase, when the paleoenvironmental conditions in the Lombardy basin (tethian domain) were usually characterized by high rate of sedimentation in a low energy regime. Recently, Lakew (1990), in a detailed biostratigraphic study on this formation, recognized and described 14 different microfacies, coming from shallow basinal to intertidal environment.

The sample containing *Macroporella retica*, collected from a calcareous bed, is characterized by fossiliferous wackestone and packstone partially dolomitized. Macrofossils are represented mostly by bryozoans, corals, gastropods, pelecypods, particularly evident on the weathered surface.

Microfossils are represented by the foraminifers *Triasina hantkeni* Majzon, *Trochammina almtalensis* Koehn-Zaninetti, *Aulotortus tumidus* Kristan-Tollmann, *Aulotortus* spp., *Frondicularia woodwardi* Howchin, *Gandinella apenninica* Ciarapica & Zaninetti, *Glomospira* spp., *Glomospirella pokornyi* Salaj, *Trochammina alpina* Kristan-Tollmann, *Trochammina* spp., by problematical organisms *Bacinella irregularis* Radoicic, *Thaumatoporella parvovesiculifera* Raineri, juvenile ammonites, small gastropods, echinoid spines, coral, pelecypod and bryozoan fragments, ostracods.

Even though the chronostratigraphical value of Rhaetian biozones is still debated, the foraminiferal assemblage suggests to assigne this interval to the *Triasina hantkeni* zone, following the foraminiferal zonation introduced by Gazdzicki (1974).

Description. The calcareous skeleton is simple, without ornamentation, not articulated, slightly club-shaped (Pl. 1, fig. 6). The top of the thallus has not been observed in the studied material; however, based on the shape of the apical area in axial section (Pl. 1, fig. 6), it is possible to assume that it was hemisphaerical. The central cavity is very large if compared with the calcareous wall. The outer diameter ranges between 0.65 mm and 3.72 mm, the inner diameter between 0.40 mm and 3.1 mm (the values are listed in Tab. 1). The inner diameter reaches the maximum frequency between 1.0 mm and 1.4 mm, whereas the outer diameter between 2.0 mm and 2.2 mm.

The shape of the pores is rather variable most likely due to the various degree of calcification that envelopes a different portion of the branches (Fig. 2). In fact, when the calcareous skeleton covers only the distal portion of the branch (Pl. 3, fig. 16), it seems to be cylindrical in shape. On the contrary, mainly in the small and medium-sized specimens, where the calcification is so thick to cover also a more proximal part of the branch, it is possible to observe that the diameter of the thin and curved pores increases in size towards the periphery with a narrowing to the distal end (Pl. 3, fig. 17). On the basis of these considerations, in different areas of the same alga, it is possible to observe different shape of the pores, relating to the various degree of calcification (Fig. 2). As already noted by Barattolo et al. (1993), in the specimens where the calcification is so thick to cover also the most distal portion of the branches, the calcareous skeleton forms thin apophysis extending outwards, that in cross section appear to have a semilunar shape (Pl. 3, fig. 12 and 14).

	AV.1-28	MB-S51 AB	878	A.7776	A8141.1-10	A.8141.11-19
D	*0.65-3.72* [1.98±0.65] (100)	*1.44-3.88* [2.17±0.77] (11)	*0.53-3.64* [2.03±0.67] (156)	*0.64-4.60* [2.11±0.67] (146)	*0.73-3.12* [1.86±0.66] (77)	*0.79-2.91* [1.77±0.50] (89)
d	*0.40-3.1* [1.59±0.62] (100)	*1.08-3.20* [1.69±0.68] (11)	*0.31-2.91* [1.57±0.58] (156)	*0.44-3.64* [1.74±0.60] (147)	*0.42-2.6* [1.37±0.57] (77)	*0.51-2.35* [1.33±0.43] (89)
e	*0.12-0.25* [0.19±0.069] (100)	*0.16-0.34* [0.24±0.053] (11)	*0.10-0.42* [0.23±0.068] (156)	*0.08-0.42* [0.19±0.058] (147)	*0.10-0.36* [0.24±0.067] (77)	*0.13-0.33* [0.22±0.044] (89)
w	*14-33* [21.63±5.61] (18)			*12-31* [20.0±5.8] (8)		*16-21* [18.6±1.9] (5)
p	*0.12-0.28* [0.19 ±0.036] (30)	*0.122-0.20* [0.15±0.038] (6)	*0.051-0.15* [0.09±0.021] (30)	*0.063-0.24* [0.12±0.026] (77)	*0.063-0.11* [0.089± 0.013] (13)	*0.070-0.16* [0.105±0.020] (8)

Tab. 1 - *Macroporella retica* Zanin Buri 1965 [= *Griphoporella curvata* (Gümbel 1872) Pia 1915]. Values of the most significant biometrical parameters for the studied samples (AV. 1-28) and those reported by Barattolo et al. (1993). The range of variability is in italic type; the average values and standard deviation are in squared; the number of measurements are in brackets. All dimensional values are in millimeter (D=outer diameter of the thallus; d=inner diameter of the thallus; e=thickness of the calcareous wall; w=number of the pores for each verticil; p=diameter of the pores).

The pores intersected in transversal section are circular or slightly elliptical (with the major axis placed horizontally), the diameter varies between 0.12 and 0.28 mm.

Only first order branches exist. In the small and medium-sized specimens, where the calcification is probably so thick to reach most of the branch extent, the pores at their inner portion exhibit an inclination of about 60°, gradually increasing in the distal portion (Pl. 3, fig. 13). In larger specimens, where the calcification probably covers a small extend of primary branches the pores are moderately tilted (about 80°) or almost perpendicular to the central axis.

The branches arrangement is usually a character difficult to detect because only the peripheral part of the primary branches is preserved. However, in some oblique or tangential sections an euspondyl arrangement with alternate verticils is observed (Pl. 2, fig. 7, 8). In this case the pores are aligned both horizontally and vertically. The horizontal space between two pores of the same verticil is bigger than the vertical distance between two verticils. The number of pores for each verticil changes between 14 and 33 (this value has been calculated on 18 specimens).

As already mentioned, due to the thin calcification, it is often difficult to estimate the shape of the branches which appears to vary from acrophorous to phloio-

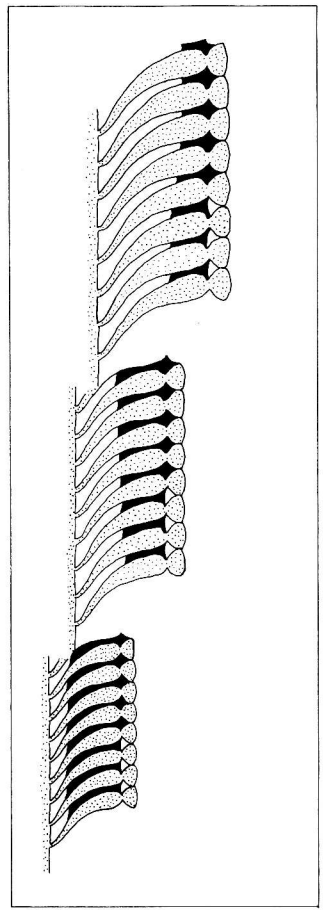

Fig. 2 - *Macroporella retica* Zanin Buri 1965 [= *Griphoporella curvata* (Gümbel 1872) Pia 1915]. Schematic reconstruction of axial section of large, medium and small thallus showing that different pore morphologies are due to different degree of calcification.

phorous. A detailed analysis, on several sections, shows that the diameter of the branches increases outward (phloiophorous type), with a narrowing at the distal end (Pl. 3, fig. 17). In particular, mostly in the small and medium-sized specimens, when the calcification is thicker, the phloiophorous shape is better marked and their distal part suddenly swells with a narrowing at the distal end (Pl. 3, fig. 17). On the contrary, when the calcification covers only the peripheric part of the branches (Pl. 3, fig. 16), the shape seems to be acrophorous or slightly phloiophorous, with a very slow increase of the diameter outwards (Pl. 3, fig. 16). Moreover the calcification probably never envelopes the innermost part of the branches close to the central stem, which is therefore never visible (Barattolo et al., 1993).

At the distal end, the branches widening are mutually compressed and this character could be an indirect witness of a cortex. Reproductive organs are unknown, most likely not calcified.

Statistical analysis. In order to give the range and frequency variability of the main biometric parameters, a statistical analysis has been performed. These observations

have been carried out on one sample very rich of algae, collected from the type-locality. From this sample, 26 thin sections containing about 100 algae specimens in different kind of section, have been prepared and analyzed (all measurements are reported on Tab. 2). In some cases, it has not been possible to assess the range of the biometrical characters, due to bad preservation of the algae caused by the presence of recrys-

specimen	sample	D	d	e	w	p	specimen	sample	D	d	e	w	p
1	AV.1.1	0,85	0,5	0,175			51		3,2	2,7	0,25		
2		1,2	0,8	0,2			52		1,6	1,22	0,19		
3	AV.1.2	3,8	3,2	0,3	32		53		3,1	2,6	0,25	28	
4	AV.1.3	1,7	1,3	0,2		0,22	54		3,1	2,6	0,25		0,21
5	AV.1.4	1,2	0,9	0,15	14		55		3	2,9	0,05		0,23
6		1,4	1,15	0,125			56		1,5	1,1	0,2	20,5	
7		1,7	1,4	0,15			57		1,5	1	0,25		
8	AV.1.5	1,8	1,3	0,25			58		2,1	1,75	0,175		
9	AV.1.6	2	1,7	0,15			59		2,3	1,9	0,2		
10	AV.1.7	1,2	0,9	0,15			60		2	1,7	0,15		
11		1,5	1,1	0,2		0,16	61	AV.1.22	2,2	1,5	0,35		
12		1,6	1,31	0,145			62		1,7	1,3	0,2		0,12
13	AV.1.9	1,6	1,3	0,15		0,16	63		1,3	1	0,15		
14		1,6	1,3	0,15	15,5	0,14	64		2,8	2,1	0,35		0,23
17	AV.1.10	1,5	1,1	0,2			65		1,6	1,2	0,2		
16		1,5	1,1	0,2	14		66	AV.1.23	2,5	2	0,25	22	
15		0,9	0,5	0,2			67		2,5	1,9	0,3		
18	AV.1.11	3,1	2,6	0,25		0,24	68		1,7	1,3	0,2		0,23
19		2,7	2,22	0,24			69		1,7	1,4	0,15		
20	AV.1.12	1,1	0,8	0,15			70		1,4	1	0,2		
21	AV.1.13	1,2	1	0,1			71		2	1,7	0,15		
22		1	0,8	0,1		0,15	72		2,6	2,1	0,25		
23	AV.1.14	1,9	1,5	0,2		0,17	73		2,3	1,9	0,2		
24		3	2,8	0,1		0,23	74		2,5	2,2	0,15	26	
25		1,9	1,5	0,2			75		1,5	1	0,25		0,19
26	AV.1.15	1,6	1,2	0,2			76	AV.1.24	2,3	1,9	0,2		
27		1,4	1	0,2		0,12	77		2,8	2,1	0,35		
28	AV.1.16	1,4	1,2	0,1			78		3,1	2,6	0,25		
29	AV.1.17	1,2	0,9	0,15	14	0,15	79		1,8	1,6	0,1		0,18
30		1,2	0,9	0,15			80		1,1	0,6	0,25		
31	AV.1.19	3,1	2,7	0,2			81	AV.1.18	2	1,7	0,15		0,17
32		1,6	1,3	0,15			82		3,6	3,1	0,25		
33		2,3	2	0,15	21		83	AV.1.26	1,7	1,2	0,25		
34		2,3	2	0,15			84		2,6	2,2	0,2		0,21
35		2,7	2,4	0,15		0,21	85		2,5	2	0,25		0,22
36		1,4	0,9	0,25	17	0,16	86		2,2	1,75	0,225		
37		2,2	1,78	0,21	21,5		87		0,76	0,4	0,18		
38		3	2,7	0,15		0,23	88	AV.1.27	1,5	1,3	0,1		
39		1,9	1,6	0,15			89		2,7	2,22	0,24		
40	AV.1.20	2,2	1,9	0,15			90		2,1	1,7	0,2		
41		2	1,6	0,2			91		3,1	2,6	0,25		0,24
42		1,8	1,4	0,2		0,23	92		2,7	2,2	0,25		
43		1,8	1,4	0,2		0,19	93		2,4	1,9	0,25	25,5	
44		1,6	1,2	0,2			94		2,4	1,95	0,225	25,5	
45		2,2	1,9	0,15			95	AV.1.28	1,72	1,35	0,185		
46		2,1	1,75	0,175		0,22	96		1,6	1,1	0,25		
47		2,3	1,9	0,2	28		97		1,5	1,2	0,15		
48		2,1	1,75	0,175		0,2	98		1,2	0,95	0,125		
49		2,4	1,95	0,225		0,21	99		1,5	1	0,25		
50	AV.1.21	1,6	1,21	0,195		0,24	100		1,1	0,8	0,15		
							mean		1,9803	1,5911	0,1946	21,63333	0,195333
							s.d.(n-1)		0,659355	0,623948	0,055536	5,673576	0,036767

Tab. 2 - *Macroporella retica* Zanin Buri 1965 [= *Griphoporella curvata* (Gümbel 1872) Pia 1915]. Measurements of the most significant biometrical parameters analyzed for each specimen are reported. Dimensional values are in millimeters (D=outer diameter of the calcareous wall; d=inner diameter of the calcareous wall; e=thickness of the calcareous wall; w=numbers of the pores for each verticil; p=diameter of the pores).

tallized fibrous cements directly adjacent to the thallus. In particular, it has been difficult to evaluate the inner diameter and, therefore, the thickness of the calcareous wall.

The data are summarized on four diagrams (Fig. 3, 4) relating thickness of the calcareous wall (e=D-d/2) and inner diameter (d) with the specimen number; the inner diameter of the calcareous wall (d) with the outer diameter (D); the inner diameter (d) with the thickness of the calcareous wall (e=D-d/2). To simplify a qualitative comparison with *Griphoporella curvata*, the charts reported on this paper have been

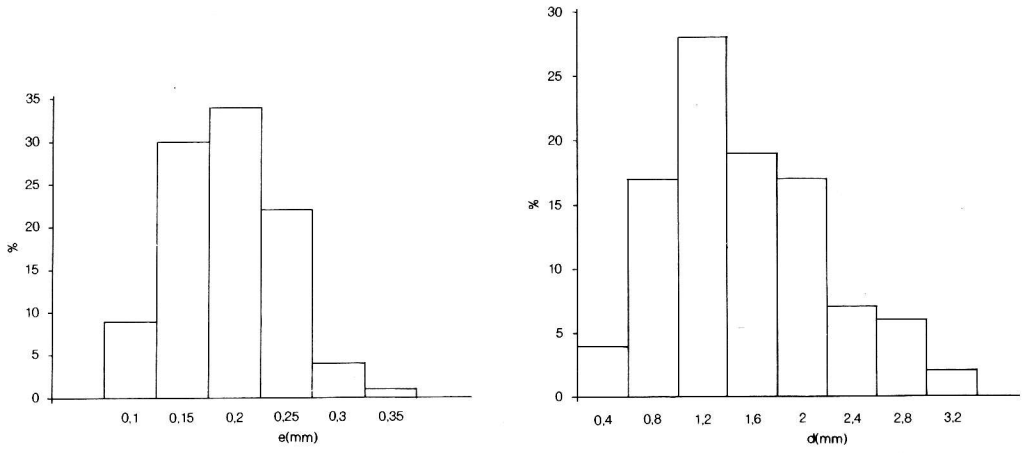

Fig. 3 - *Macroporella retica* Zanin Buri 1965 [=*Griphoporella curvata* (Gümbel 1872) Pia 1915]. Histograms of the inner diameter (d) of the thallus and thickness of calcareous wall (e). All dimensional values are in millimeters.

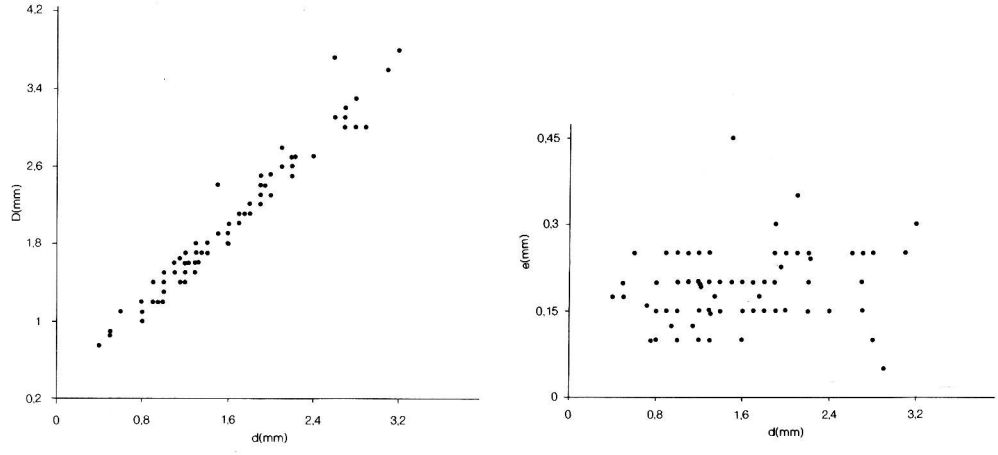

Fig. 4 - *Macroporella retica* Zanin Buri 1965 [=*Griphoporella curvata* (Gümbel 1872) Pia 1915]. The chart shows the interrelation between inner (d) and outer (D) diameter and between the inner diameter (d) and thickness of calcareous wall (e). Each spot of the charts refers to a single specimen. In the first case the correlation coefficient shows high values, whereas in the second case (inner diameter versus thickness of calcareous wall) it is much lower.

	MB-S51 AB	878	A7776	A8141.1-10	A8141.11-19
D	—	—	—	—	+
d	—	++	—	+	+
e	—	++	—	++	—
p			—		—

— not significant values
+ significant values
++ highly significant values

Tab. 3 - *Macroporella retica* Zanin Buri 1965 [= *Griphoporella curvata* (Gümbel 1872) Pia 1915]. Test F performed on the outer (D) and inner (d) diameter, thickness of the calcareous wall (e) and diameter of the pores (p), comparing each samples reported by Barattolo et al. (1993), with the sample AV.1-28.

drawn with the same variability range reported by Barattolo et al. (1993). In most cases, the results of the analysis (the range of variability of the main biometrical values has been reported on Tab. 1) demostrated that all bivariate distributions are enough regular.

Finally, to test the statistical differences between each sample containing *Macroporella retica* and *Griphoporella curvata*, the F test and covariance analysis on the main parameteres have been performed.

The F test, which helps us to ascertain the probability of two samples to belong to two populations having equal variances, has been performed on the inner diameter (d), outer diameter (D), thickness of the calcareous wall (e=D-d/2) and diameter of the pores for each verticil (p) comparing the sample AV.1-28 with all samples studied by Barattolo et al. (1993). The results of the F test reported on Tab. 3 show a dishomogeneous response; in fact some of them give a not significant result (e.g.: samples MB-S51AB and A.7776) but others give significant or highly significant results (e.g.: samples 878, A.8141.1-10 and A.8141.11-19). It is noticeable that similar behaviour is observed by Barattolo et al. (1993), testing samples containing *Griphoporella curvata* (e.g.: samples A.8141.1-10 and A.8141.11-19). In this case, it is possible to suppose that these contrasting results are not related to taxonomical differences but they are due to ecological factors or to sedimentation process.

The covariance analysis has been applied on the outer (D) and on the inner (d) diameters of the calcareous skeleton, comparing samples AV.1-28 (present study) and A.8141.11-19 (Barattolo et al., 1993). Both covariance tests give not significant results so that it is possible to consider the two algal populations as belonging to the same statistic sample.

Discussion on systematic position. The observations carried out during this study emphasized that *Macroporella retica* displays an euspondyl branches distribution. On the basis of this morphological character, it is not possible to attribute this alga to the genus *Macroporella* Pia 1912, considered by most of the authors (Deloffre & Ramahlo, 1971; Deloffre, 1988; Conrad et al., 1973; De Castro & De Rosa, 1977; Bassoullet et al., 1978) as having an aspondyl branches distribution.

On the contrary, *Macroporella retica* shows great affinity with the genus *Salpingoporella* Pia 1918. The only difference, already noted by Barattolo et al. (1993), is represented by the narrowing at the end of the branches that in *Salpingoporella* is absent. These authors, studying in very detail some samples coming from the type-locality (Bocca di Nota-Southern Alps) and from the southern Apennines, emended the diagnosis of genus *Griphoporella* as follows: "*cylindrical to slightly club - shaped simple thallus; primary branches only, slightly phloiophorous with a subterminal narrowing, arranged in alternate, very close, verticils (euspondylous type); unknown (not calcified) reproductive organs; calcareous skeleton not articulated, very thin*". On the basis of these observations, they assigned the genus *Griphoporella* to the family of Dasycladaceae, tribe Salpingoporelleae, subtribe of Salpingoporellinae.

The present study, corroborated by the statistical analysis, agrees with Barattolo et al. (1993) statement, confirming that *Macroporella retica* shows the same taxonomic characters of *Griphoporella curvata*, so that the former species can be considered a junior synonym of the latter.

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PLATE 1

Macroporella retica Zanin Buri 1965 [=*Griphoporella curvata* (Gümbel 1872) Pia 1915]. Rhaetian. Aviatico (Bergamo, Italy).

Fig. 1-3 - Oblique sections. 1) Thin section n. AV.1.19 (x 15). 2) Thin section n. AV.1.15 (x 15). 3) Thin section n. AV.1.19 (x 15).
Fig. 4 - Transverse section. Thin section n. AV.1.23 (x 15).
Fig. 5 - Oblique section. The shape of the branches can be observed. Thin section n. AV. 1.9 (x 15).
Fig. 6 - Subaxial section. Thin section n. AV. 1-2 (x 8).

PLATE 2

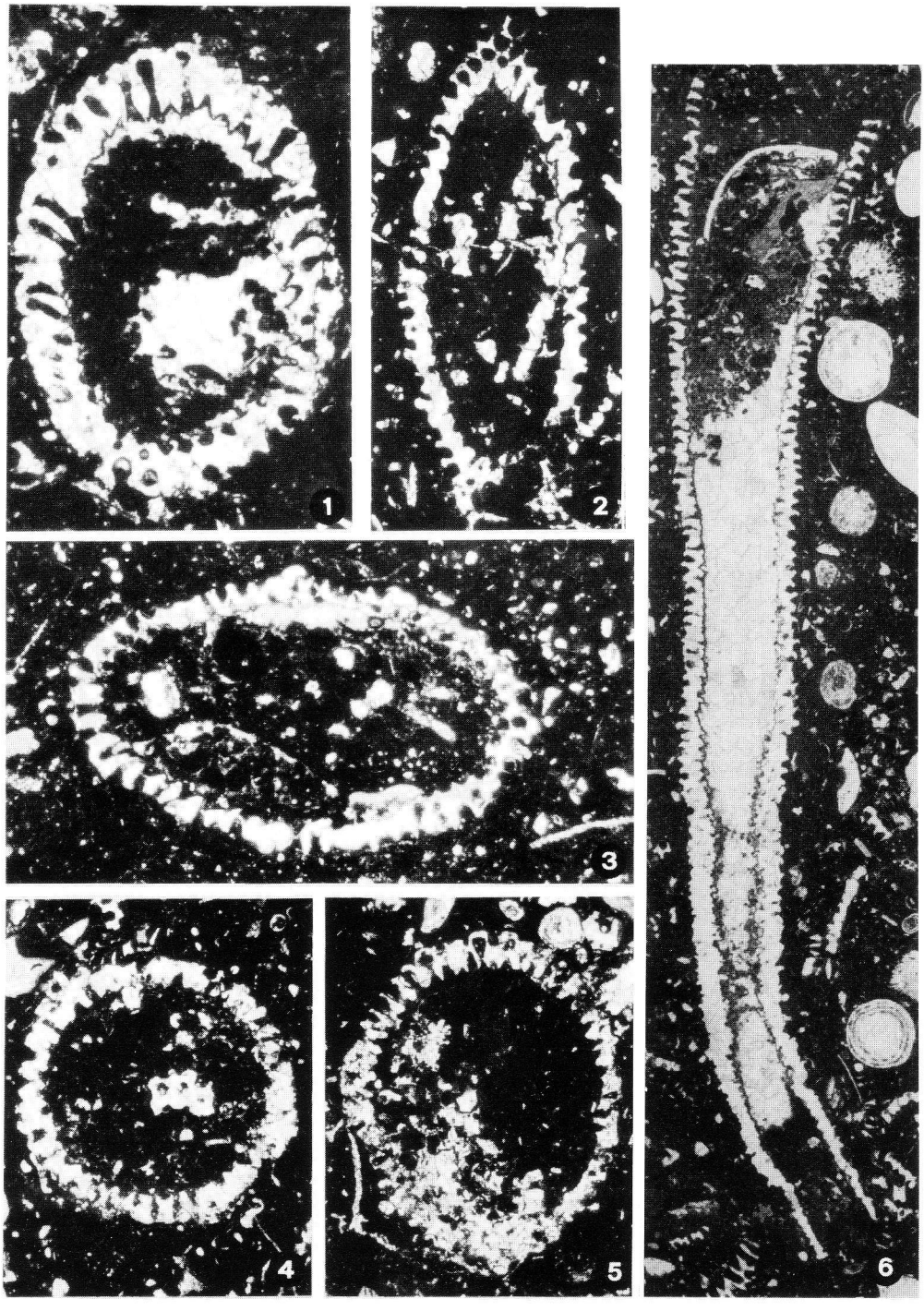
Macroporella retica Zanin Buri 1965 [=*Griphoporella curvata* (Gümbel 1872) Pia 1915]. Rhaetian. Aviatico (Bergamo, Italy) (x 30).

Fig. 7, 8 - Detail of tangential-oblique section. Euspondyl type arrangement of the branches, with verticils disposed in alternance. The vertical alignment is more clear than the horizontal. 7) Thin section n. AV.1.16. 8) Thin section n. AV. 1.7.
Fig. 9 - Detail of Pl. 1, fig. 5 showing the shape of branches, here clearly phloiophorous. Thin section n. AV.1.9.
Fig. 10 - Detail of Pl. 1, fig. 3; in this case it is possible to notice the variability of the branch shape from acrophorous to slightly phloiophorous. Thin section n. AV.1.19.
Fig. 11 - Detail of Pl. 1, fig. 1, showing the shape of the branches slightly phloiophorous. Thin section n. AV.1-19.

PLATE 3

Macroporella retica Zanin Buri 1965 [=*Griphoporella curvata* (Gümbel 1872) Pia 1915]. Rhaetian. Aviatico (Bergamo, Italy) (x 40).

Fig. 12, 14 -Details of oblique sections showing the apophysis (arrows) of the calcareous wall.
Fig. 13 - Detail of axial section showing a pronounced inflation at the base of the branches.
Fig. 15, 16 -Detail of transversal and axial sections showing the different degree of calcification.
Fig. 17 - Oblique section, showing pores with a subterminal narrowing.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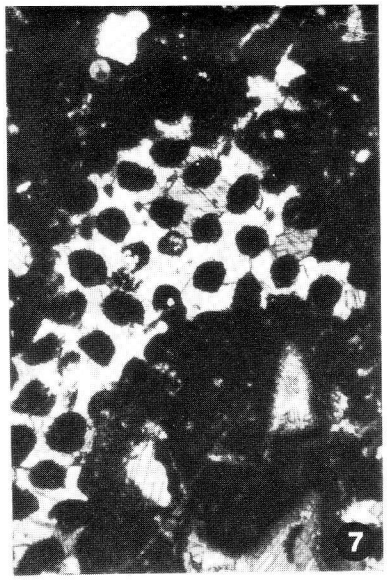
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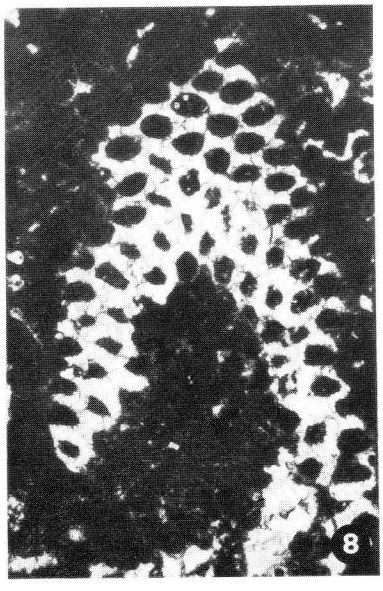
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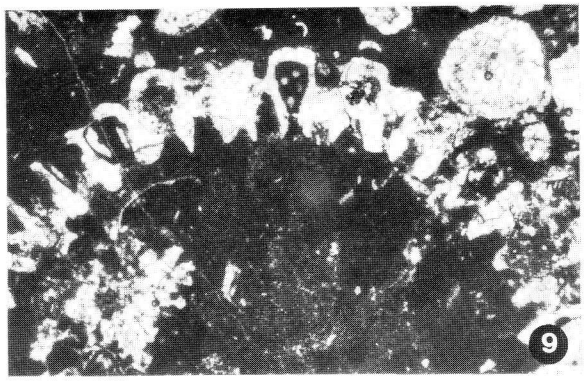
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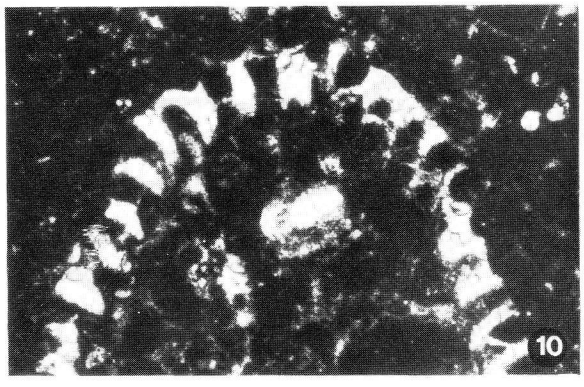
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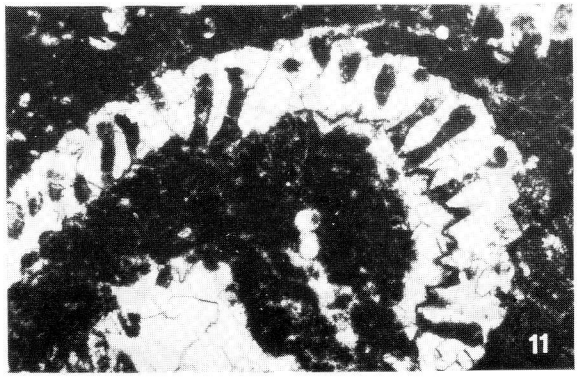
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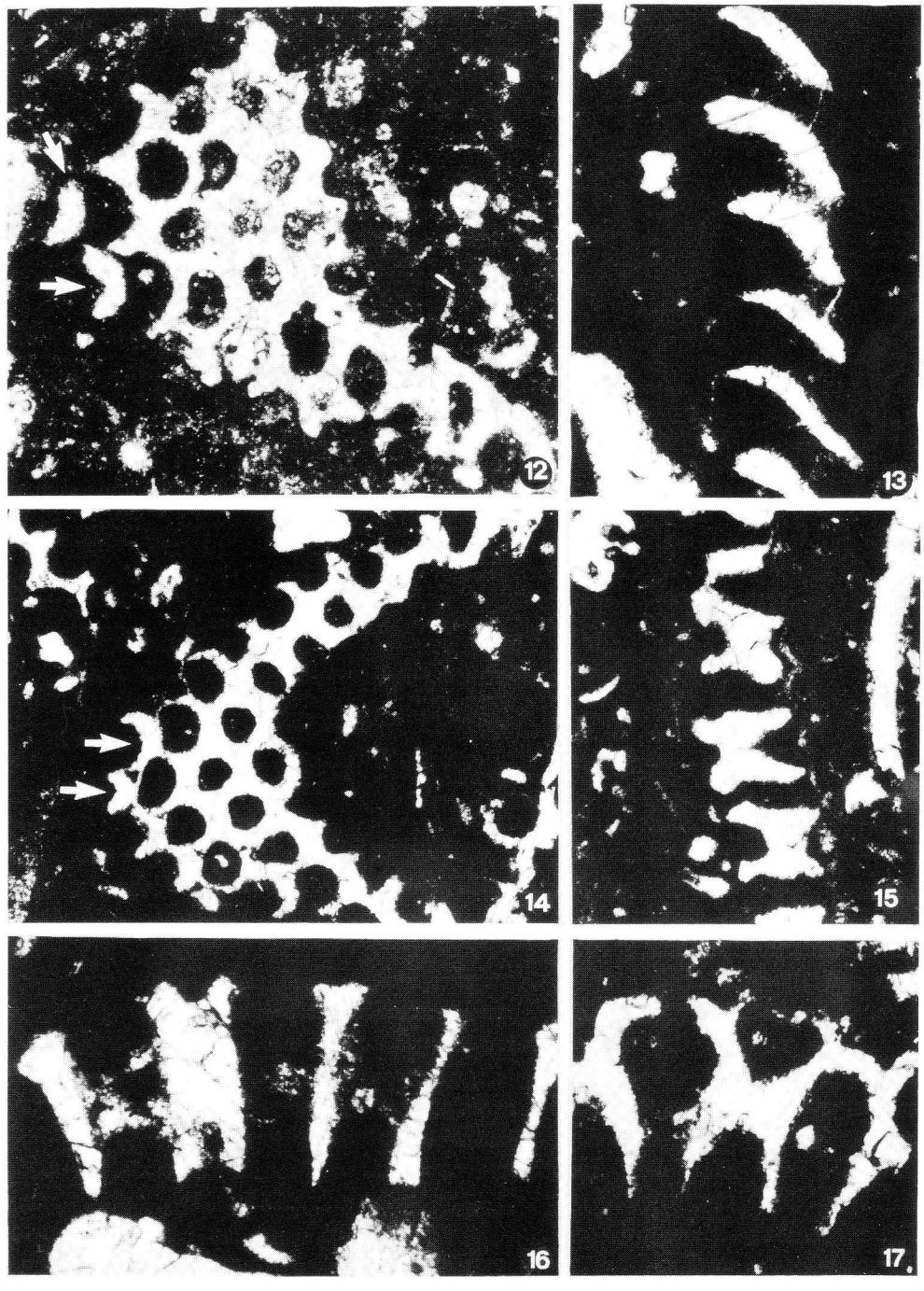
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